

efunda

engineering fundamentals

Distributions in Continuous S

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Normal Distribution

The **normal distribution**, or *Gaussian distribution*, is a symmetrical distribution commonly referred to as the *bell curve*. It can be considered as a special case of the binomial distribution with a very large number of trials ($n \rightarrow \infty$) and an equal success/failure rate ($p = q = 0.5$).

Suppose that the mean value and standard deviation of a normal distribution are μ and σ , respectively. The normal distribution has the following important properties. See [plots of normal distributions](#).

Normal Distribution

Density Function $f(x)$

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Distribution Function $F(x)$

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^x e^{-\frac{(v-\mu)^2}{2\sigma^2}} dv$$

Mean μ

μ

Variance σ^2

σ^2

Standard Deviation σ

σ

Uniform Distribution

The **uniform distribution** has a constant success rate on the interval $a \leq x \leq b$ and zero success rate anywhere else. The uniform distribution has the following properties. See [plots of uniform distributions](#).

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Uniform DistributionDensity Function $f(x)$

$$f(x) = \begin{cases} \frac{1}{b-a} & a \leq x \leq b \\ 0 & \text{otherwise} \end{cases}$$

Distribution Function $F(x)$

$$F(x) = \begin{cases} 0 & x < a \\ \frac{x-a}{b-a} & a \leq x \leq b \\ 1 & x > b \end{cases}$$

Mean μ

$$\mu = \frac{a+b}{2}$$

Variance σ^2

$$\sigma^2 = \frac{(b-a)^2}{12}$$

Standard Deviation σ

$$\sigma = \frac{b-a}{2\sqrt{3}}$$

Exponential Distribution

The **Exponential distribution** arises in the calculations of reliability. It is similar to the Poisson distribution with $x = 0$ and the probability of the desired outcome d as the trial number increases ($\lim_{n \rightarrow \infty} p = 0$). See plots of exponential distribution

Exponential DistributionDensity Function $f(x)$

$$f(x) = \begin{cases} \lambda e^{-\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases}$$

Distribution Function $F(x)$

$$F(x) = \begin{cases} 1 - e^{-\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases}$$

Mean μ

$$\mu = 1/\lambda$$

Variance σ^2

$$\sigma^2 = 1/\lambda^2$$

Standard Deviation σ

$$\sigma = 1/\lambda$$

where $\lambda = \text{constant} > 0$.